TECHNICAL REPORT S-69-4

GEOLOGICAL INVESTIGATION OF THE MISSISSIPPI RIVER AREA ARTONISH TO DONALDSONVILLE, LA.

by

R. T. Saucier

April 1969

Sponsored by

The President, Mississippi River Commission

Conducted by

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

ARMY-MRC VICKSBURG, MISS.

GEOLOGICAL INVESTIGATION OF THE MISSISSIPPI RIVER AREA, ARTONISH TO DONALDSONVILLE, LA.

GEOGRAPHIC SETTING

1. The area under consideration in this report encompasses some 2500 square miles that flank the Mississippi River between a point about 4 miles north of Artonish, Louisiana, and a point about 15 miles east of Donaldsonville, Louisiana (fig. 1). It lies almost entirely within the New Orleans District of the Corps of Engineers, extending from Mississippi River miles 152 to 327 above Head of Passes. Baton Rouge, Louisiana, is by far the largest urban complex within the area.

2. Physiographically, the study area includes the extreme southeastern part of the Lower Mississippi Valley or the Mississippi River floodplain plus a smaller area of terracelands or bluff-lands of Pleistocene age lying east of the floodplain. Throughout the area, the Mississippi River flows close to the base of the bluffs, which decrease in height downstream until, at Donaldsonville, they rise only as a low terrace 10 ft or less above floodplain level. The floodplain area west of the river is part of the large Atchafalaya Basin of Louisiana. Toward the south and southeast, the study area merges with the Mississippi River Deltaic Plain.

PURPOSES AND SCOPE

3. The purposes of this investigation have been to (a) determine the areal distribution and physical characteristics of the various alluvial deposits, (b) analyze subsurface soils conditions of various environments of deposition to aid in determining foundation and underseepage conditions, (c) determine the nature of and the depth to the Tertiary or Pleistocene deposits lying beneath the Recent alluvium, and (d) delineate the major geologic formations or basic lithologic types in the uplands or blufflands. During the past decade, the U. S. Army Engineer Waterways Experiment Station (WES) has been conducting continuing investigations of the Yazoo, St. Francis, and Boeuf-Tensas Basins of the Lower Mississippi Valley with similar goals. In all cases, including the present study, the basic data presentation form is a standard 1:62,500-scale topographic quadrangle supplemented by one or more geologic cross sections. The 10 quadrangles included herein are thus part of what will ultimately be almost complete engineering-geologic quadrangle map coverage of the Lower Mississippi Valley area. A loose-leaf folder format has been adopted for the report series to facilitate addition of supplemental data and/or revisions.

MAPPING PROCEDURE

4. The areal distribution of the Recent environments of deposition was determined largely from aerial photos and photo mosaics ranging in scale from 1:10,000 to 1:63,360 and in date from the 1930's to the 1960's. Pertinent geological publications such as groundwater investigations and state geological survey bulletins, and unpublished data from manuscript reports and graduate theses (see plates for references) provided much of the data on the Pleistocene and Tertiary formations exposed in the uplands and beneath the Recent alluvium.

5. A large volume of subsurface data was obtained from the files of agencies such as the U. S. Army Engineer District, New Orleans, the U. S. Geological Survey, the Louisiana Department of Highways, several private foundation engineering firms, and numerous private industries with plants in the area. The more detailed subsurface information, usually the logs of holes drilled by the Corps of Engineers, was used to construct cross sections through the various quadrangle areas and to contour the surface of the entrenched valley.

GEOLOGIC SETTING

6. Deposits of Tertiary age are exposed in the uplands only at a few small and scattered localities north of St. Francisville, Louisiana (fig. 1). These materials everywhere are fine-grained and are identified as undifferentiated Pliocene-Miocene deposits, probably being either the Pascagoula or the Hattiesburg formation equivalents (see reference 1 for further information on Tertiary stratigraphy). Fluvial deposits of Pleistocene age, characteristically graveliferous, form a nearly continuous thin blanket over the Tertiary formations north of Zachary, Louisiana (reference 2 contains detailed descriptions of the deposits). South of this point (fig. 1), the fluvial deposits are in the form of well-defined terraces that lack near-surface graveliferous units and that thicken rapidly southward to thicknesses of at least several hundred feet (reference 3). The youngest terrace, designated as the Prairie formation (Qtp) according to Fisk (reference 4), is widespread and easily identifiable. Although all of the older Pleistocene deposits north of Zachary have also been differentiated by Fisk into terrace formations, recent investigations by Parsons (reference 2) and others have indicated that alternate interpretations are tenable but not definitive. Such deposits are identified only as undifferentiated Pleistocene deposits (Qtu) in this report.

7. The base of the Recent alluvium is an entrenched surface displaying a dendritic drainage pattern. The average elevation of the surface is well over 100 ft below floodplain level, and maximum depths of as much as 350 ft below floodplain level occur in the deepest trench. The entrenched surface was created during late Pleistocene times as a result of the Mississippi River and various tributaries adjusting their gradients to lower-than-present sea levels during periods of continental glaciation. North of the latitude of Zachary, Louisiana, the entrenchment affected Tertiary formations, while south of this latitude, Pleistocene formations are present and form the entrenched surface. The contact between the two is interpreted to be along a major fault zone known as the Bancroft Fault Zone (reference 5). This fault zone (shown in plates Fordoche (a) and New Roads (a)) is one of several in the study area that trend roughly east-west and that are composed of parallel normal faults with near-surface displacements of several tens of feet.

8. The oldest Recent deposits filling the entrenched valley are included in the thick wedge of fluvial substratum sands and gravels. This unit is by far the thickest and most continuous body of sediments of essentially one type that occurs in the study area or in the entire Mississippi Alluvial Valley. At occasional points above the deeper entrenchments, substratum deposits attain a thickness of 300 ft. The typical substratum sequence is fine sands grading downward into progressively coarser sands. The first gravels appear at depths of 75 to 150 ft and become more abundant and larger in size with increasing depth.

9. Substratum deposits below a depth of 80 to 100 ft were deposited by shallow, swiftly flowing, braided courses of the Mississippi River when it was carrying large volumes of coarse glacial debris. Those substratum deposits above this depth, largely limited to the area of the present Mississippi River meander belt, were deposited by the river since it changed from a braided to a meandering regimen, possibly about 12,000 years ago.

10. Deposits laid down since that time are all relatively fine-grained and are subdivided according to environment of deposition. Figure 2 summarizes the characteristics of the six major environments recognized in the study area that collectively are referred to as topstratum deposits.

11. Sediments deposited in the backswamp environment are by far the thickest and areally most extensive in the study area. Initial deposition began about 12,000 years ago when the Mississippi River followed a course along the western side of its alluvial valley and continued uniformly across the study area until about 4,000 years ago, at which time the river shifted to a course along the eastern side of the valley. Backswamp deposits continued to accumulate along the flank of the new meander belt; however, meandering of the river within the new meander belt resulted in the erosion and removal of large areas of backswamp deposits. These deposits were replaced largely with point bar deposits and deposits that accumulated in abandoned channel environments.

12. Several small distributaries such as Bayou Latenache, Bayou Fordoche-Bayou Grosse Tete, and Bayou Plaquemine (see plates for locations) are apparent in the area because of their well-developed natural levee ridges. These distributaries were apparently short-lived, carried only a small volume of flow only at flood stages on the river, and originated as crevasses. Bayou Lafourche is the only distributary in the study area that carried all or a significant portion of the Mississippi River discharge (reference 6).

DATA PRESENTATION

13. The plates in this folio show the distribution of alluvial deposits in plan and in profile. On each of the base maps (plates designated "a"), which are full-scale reproductions of the latest standard 1:62,500-scale topographic quadrangles, four of the six environments of deposition of the topstratum are shown in color. The other two environments, the alluvial apron and the natural levee deposits, are shown as a dashed and a dotted overprint, respectively, in order that the types of deposits lying beneath these two essentially surficial deposits will not be masked. Heavy black dashed lines are used to show the locations of selected major swales in point bar areas that illustrate the trends of the meanders.

14. A green line pattern is used to delineate that part of the backswamp environment where the deposits are unusually thin. This situation occurs along a narrow, discontinuous band that is interpreted as being the location of the meander belt of the local valley drainage system that was situated near the eastern valley wall while the Mississippi River was flowing near the western valley wall. The thin backswamp and natural levee deposits now overlying and obscuring all surface expression of the meander belt were deposited after the Mississippi River adopted its present course near the eastern valley wall.

15. A blue checkered pattern is used to portray large swalelike areas of various origins (e.g., crevasse scourings and areas of slack-water deposition behind bars) where thick deposits of soft, fine-grained materials (almost exclusively clays) occur. Certain areas of point bar environment are delineated by a fine dotted red overprint. In these areas, the point bar deposits are considerably finer grained than is typical for the environment. This situation develops where the river is forced to meander in an anomalous manner due to its impingement against the highly erosion-resistant Pleistocene or Tertiary uplands. Deposition of fine-grained materials (mostly silts with clay layers) actually results from an eddy and/or slack-water condition that develops in the bend.

16. The elevations of the surfaces of the entrenched Tertiary or Pleistocene formations are shown by red contours. The borings used to contour the surfaces are shown as small red dots.

17. Where boring information is sufficient, one or more cross sections have been prepared to accompany each map. Each plate containing cross sections bears the designation "b." Where information is sufficiently detailed, principally where closely spaced engineering borings have been made, the soil types are shown in color. Note that soil types are shown only to the depths of the detailed borings.

18. The classification of soil types used in the cross sections is based on the system used by the Lower Mississippi Valley Division, CE, prior to 1950. This was unfortunately necessary because of the large number of borings used in the study that predate 1950. For comparison with more recent borings classified by the Unified Soil Classification System (USCS), and in order that these borings could be used in the study, probable equivalents of the older system and the USCS were determined and are shown in the legend. It is emphasized, however, that the two systems cannot be equated precisely; for example, soils classified as lean clay (CL) according to the USCS may occasionally be included with the older system soil types shown in blue (clay sand, sandy clay, silt, sandy silt) as well as with those shown in green (clay, blue mud, silty clay, clay silt).

MAPPING LIMITATIONS

19. The maps and cross sections in this folio should be considered as being of a reconnaissance nature only. The aerial photo interpretation could be field checked to only a limited degree, and borings were not available as substantiating data in many areas. Furthermore, the mapping technique allows for little quality control, i.e. features of doubtful origin and/or areal extent necessarily are portrayed in the same manner as are well-defined ones of unequivocal origin. Also, it should be kept in mind that the accuracy of individual contacts, contours, and other designations is affected by the scale of the map, limitations in the source data, and progressive errors that may develop during the several stages of drafting and printing. In no case should an accuracy in plan of more than ±200 ft be expected for the position of a contact, contour, or other designation.

LITERATURE CITED

1. Saucier, R. T., "Geological Investigation of the Boeuf-Tensas Basin, Lower Mississippi Valley," Technical Report No. 3-757, Feb 1967, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

2. Parsons, B. E., Geological Factors Influencing Recharge to the Baton Rouge Ground-Water System, with Emphasis on the Citronelle Formation, unpublished Master's thesis, Louisiana State University, Baton Rouge, La., Aug 1967.

3. Meyer, R. R. and Turcan, A. N., Jr., "Geology and Ground-Water Resources of the Baton Rouge Area, Louisiana," Water Supply Paper 1296, 1955, U. S. Geological Survey, Washington, D. C.

4. Fisk, H. N., "Geological Investigation of the Alluvial Valley of the Lower Mississippi River," Dec 1944, Louisiana State University, Baton Rouge, La.; prepared for Department of the Army, Mississippi River Commission, CE, Vicksburg, Miss.

5. Winner, M. D., Jr., Forbes, M. J., Jr., and Broussard, W. L., "Water Resources of Pointe Coupee Parish, Louisiana," Water Resources Bulletin No. 11, Mar 1968, Louisiana Geological Survey, Baton Rouge, La.

6. Kolb, C. R. and Van Lopik, J. R., "Geology of the Mississippi River Deltaic Plain, Southeastern Louisiana," Technical Report No. 3-483 (2 vols), July 1958, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

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Fisk, H. N. et al., "Geological Investigation of the Atchafalaya Basin and the Problem of Mississippi River Diversion," Apr 1952, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.; prepared for Department of the Army, Mississippi River Commission, CE, Vicksburg, Miss.

Kolb, C. R., "Distribution of Soils Bordering the Mississippi River from Donaldsonville to Head of Passes," Technical Report No. 3-601, June 1962, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Morgan, C. O., "Ground-Water Resources of East Feliciana and West Feliciana Parishes, Louisiana," Oct 1963, Louisiana Department of Public Works, Baton Rouge, La.

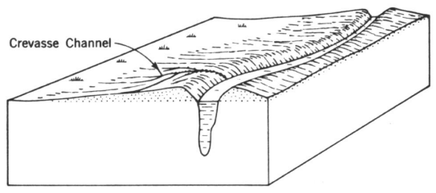
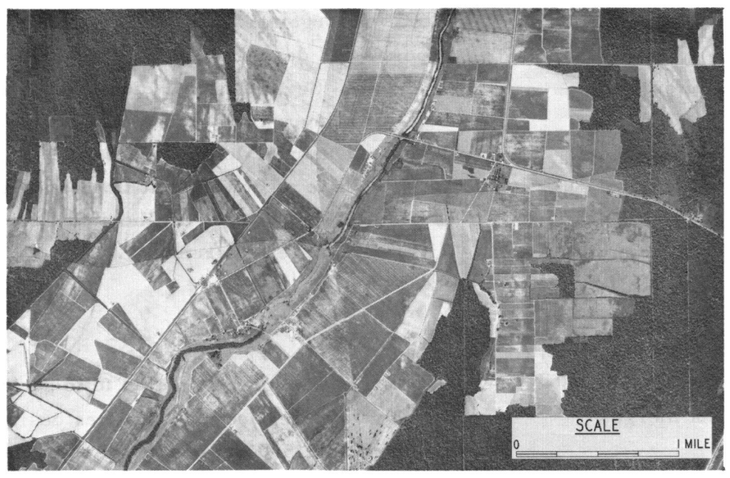
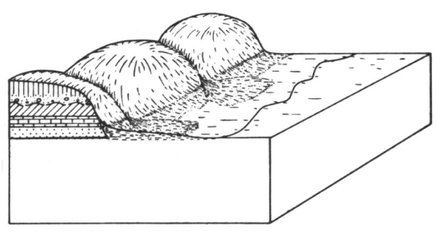
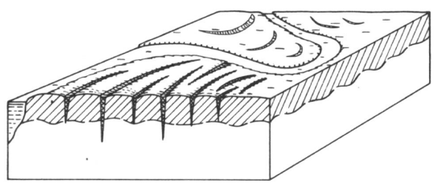
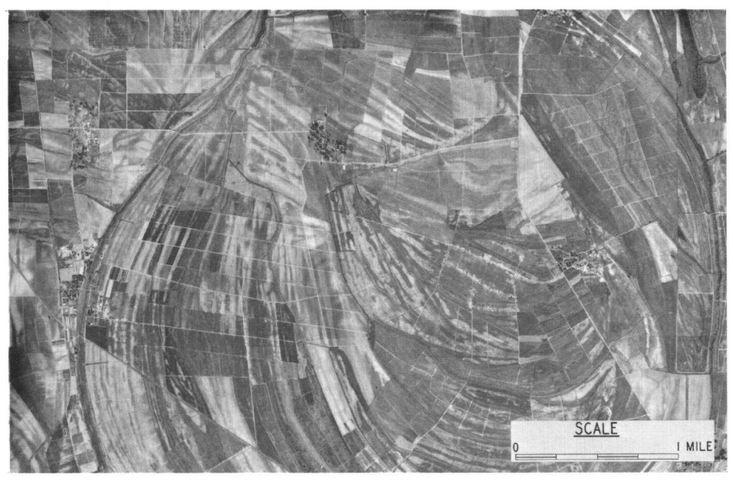
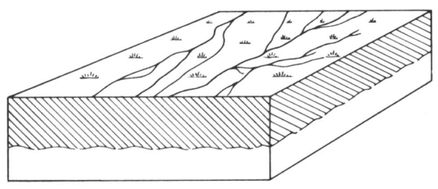
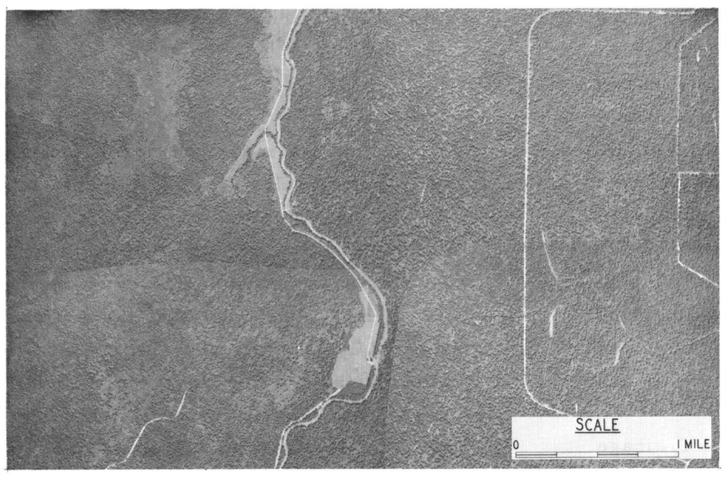
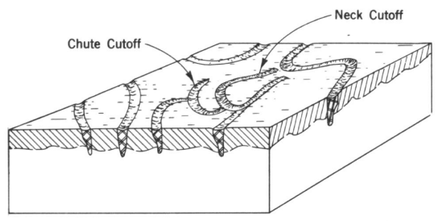
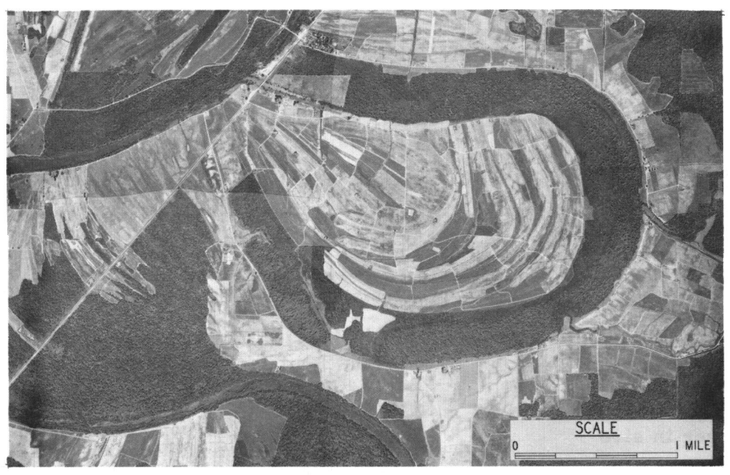
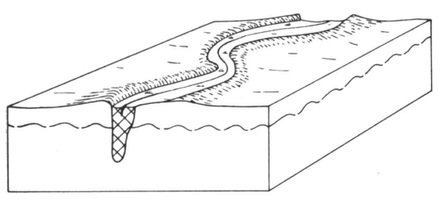
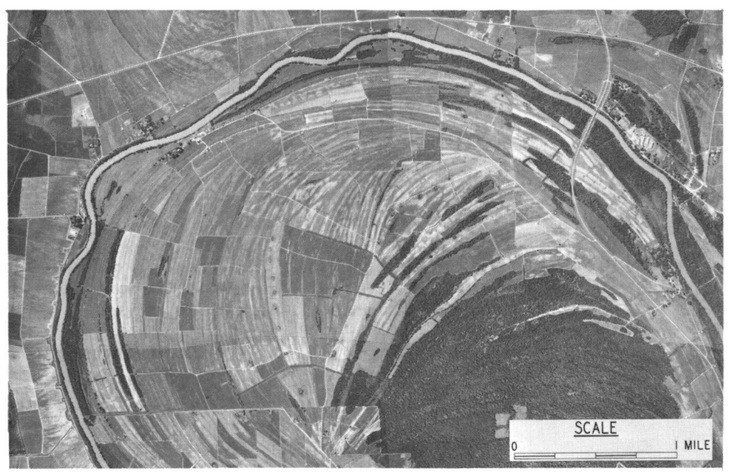
TYPE OF TOPSTRATUM DEPOSITS	DIAGRAMMATIC ILLUSTRATION	APPEARANCE ON AERIAL PHOTOGRAPHS	METHOD OF DEPOSITION	OCCURRENCE AND CHARACTERISTICS
NATURAL LEVEE			Natural levees are low ridges which flank both sides of streams that periodically overflow their banks. Since the coarsest and greatest quantities of sediment are deposited closest to the stream channels, the natural levees are highest and thickest in these areas and gradually thin away from the channels. In general, the greater the distance from the stream, the greater the percentage of the finer grained sediments. Minute drainage channels trending at right angles to the parent stream (down the backslope of the levees) are rather common; major crevasses are indicated when these channels are large and pronounced. Abandoned crevasse channels are often filled with sediments that are distinctly coarser than the remainder of the natural levee.	The largest and most widespread natural levees in the area occur along the present course and major abandoned distributaries of the Mississippi River. They attain crest heights of 15 to 20 ft above the adjacent backswamp areas, and may be 3 miles or more in width. Natural levees also occur along smaller streams in the area; however, they are appreciably narrower and steeper than those along the Mississippi River. Typical natural levee deposits consist of stiff to very stiff, brown to grayish-brown silts, silty clays, and clays that exhibit moderate to high degrees of oxidation. Natural water contents of the deposits are typically low, and organic matter is seldom present except in the form of roots.
ALLUVIAL APRON			Alluvial aprons are combinations of alluvial and colluvial deposits which overlie the floodplain deposits along the valley walls and along the sides of upland remnants within the valley. Typically, symmetrical alluvial fans are present at the mouths of streams that drain the uplands. When these streams are rather closely spaced, the fans coalesce to form the alluvial aprons. When the streams are more widely spaced, the fans are separated, and the intervening portions of the aprons are composed mainly of sediments that have washed down from the uplands or that have moved downslope by soil creep (colluvial deposits).	Alluvial apron deposits are not widespread in this area: they occur intermittently along the eastern valley wall north of St. Francisville, La. They are best developed near the mouths of the small streams that enter from the uplands and particularly where they overlie backswamp deposits and thus have not been affected by river migration. Reflecting the composition of the materials in the uplands (loess and terrace deposits primarily), the alluvial apron deposits consist of clayey silts, silts, and fine sands. Coarser sand and possibly even small quantities of gravel may be present near the mouths of the more active upland streams. Because they are well drained, they are oxidized and generally similar to natural levee deposits.
POINT BAR			Point bar deposits consist of sediments laid down on the insides of river bends as a result of meandering of the stream. Although the deposits extend to a depth equal to the deepest portion or thalweg of the parent stream, only the uppermost, fine-grained portion is included as part of the topstratum. Within the point bar topstratum, there are two types of deposits: silty and sandy, elongate bar deposits or "ridges" which are laid down during high stages on the stream, and silty and clayey deposits in arcuate depressions or "swales" which are laid down during falling river stages. Characteristically, the ridges and swales form an alternating series, the configuration of which conforms to the curvature of the migrating channel and indicates the direction and extent of meandering.	Point bar deposits are widespread only along the present course of the Mississippi River, particularly north of Baton Rouge, La. The topstratum deposits consist of tan to gray clays, clayey silts, silts, and fine sands in the ridges, and soft gray clays and silty clays in the swales. Typically, the point bar topstratum (excluding major swales) averages about 20 to 40 ft thick. However, in certain areas where the river has meandered anomalously due to impingement against the valley wall, the topstratum may be as much as 80 to 100 ft thick. Both water and organic contents are high in swales and in the anomalously thick topstratum areas, whereas they are both commonly low in the ridge deposits.
BACKSWAMP			Backswamp deposits consist of fine-grained sediments laid down in broad, shallow basins during periods of stream flooding. The sediment-carrying floodwater may be ponded between the natural levee ridges on separate meander belts, or between natural levee ridges and the uplands or upland remnants within the alluvial valley. Backswamp areas typically have very low relief and a distinctive, complicated drainage pattern in which the channels alternately serve as tributaries and distributaries at different times of the annual flood cycle.	Backswamp deposits are by far the most characteristic materials in the area, being present and virtually uninterrupted by other deposits over thousands of square miles. Average deposit thicknesses vary from about 75 to 80 ft in the northern part of the area to about 110 ft in the southern part. Total thicknesses of fine-grained materials (topstratum deposits) may reach 130 ft where natural levee deposits overlie backswamp deposits. Soft to stiff, gray to dark gray-brown clays and silty clays are the typical backswamp deposits. Occasional thin layers of silt or sand may be found, and organic matter in the form of disseminated particles, peat layers, and large wood fragments is numerous. Average water contents of the deposits are moderately high but less than those of channel and swale fillings.
ABANDONED CHANNEL			Abandoned channels, or "clay plugs" as they are commonly called, are partially or wholly filled segments of stream channels formed when the stream shortens its course. Soon after formation, they are usually characterized by open water or oxbow lakes. Subsequently, they may become essentially filled and occasionally completely obscured by various meander belt deposits. The abandoned segment may represent an entire meander loop formed by the stream cutting directly across a narrow neck of two converging arms of a loop (a neck cutoff), or it may represent a portion of a loop formed when a stream occupies a large point bar swale during flood stage and abandons the outer portion of the loop (a chute cutoff).	Abandoned channels of the Mississippi River are not numerous in this area and occur only north of Baton Rouge, La. Individual abandoned channels vary in length from a few miles to 20 miles or more, have widths of 3000 to 5000 ft or more, and usually exceed 100 ft in depth. The upper portions of the arms of the loops of neck cutoffs are normally filled with a short wedge of fine sand and silty sand. The soft, gray or blue-gray clays with high water contents that occur around the loop between the sand wedges comprise the "clay plug" portion of the abandoned channel. Homogeneous, soft, fat clays 100 to 120 ft thick have been encountered in Mississippi River clay plugs.
ABANDONED COURSE AND DISTRIBUTARY			Abandoned courses are lengthy segments of a river abandoned when the stream forms a new course across the floodplain. The abandoned course, varying from a few miles up to hundreds of miles in length, gradually fills with sediment and is often occupied by a smaller or underfit stream. In many cases, the smaller stream meanders within the confines of the larger meander belt and destroys segments of the abandoned course. In other cases, the smaller stream delineates the extent of the abandoned course when there are no other indications of its presence. Abandoned distributaries, characteristic features of the deltaic plain, are analogous in both morphology and lithology to abandoned courses although any one distributary may never have carried all or even a substantial part of the total stream discharge.	Bayou Lafourche marks the position of the only major Mississippi River abandoned distributary in the area. There are no major abandoned courses in the area mapped and all other distributaries are small and were apparently quite short lived. Only sparce data are available on the nature of the deposits filling the abandoned distributaries. A large downstream-thinning sand wedge is known to be present in the Lafourche distributary; however, the smaller distributaries appear to be filled almost entirely with fine-grained sediments. The physical characteristics of the fine-grained materials should be essentially the same as those of abandoned channel deposits.

Fig. 2. Nature and occurrence of Recent topstratum deposits, Mississippi River area, Artonish to Donaldsonville, La.

FOREWORD

Authorization for this study is contained in a letter from the Division Engineer, U. S. Army Engineer Division, Lower Mississippi Valley, to the Director, U.S. Army Engineer Waterways Experiment Station (WES), dated 9 July 1965, subject, "Status of Soils Division Projects for MRC and LMVD for FY 1965 and Request for Funds for Projects for FY 1966."

The collection and interpretation of data for this study and the preparation of the text and plates for this report were accomplished by Dr. R. T. Saucier, Geology Branch, Soils Division, WES. All work was conducted under the direct supervision of Dr. C. R. Kolb, Chief of the Geology Branch, and Mr. W. B. Steinriede, Jr., Chief of the Civil Projects Section, Geology Branch, and under the general supervision of Messrs. W. J. Turnbull and A. A. Maxwell, Chief and Assistant Chief, respectively, of the Soils Division, WES.

Directors of the WES during the conduct of this study and the preparation of this report were COL John R. Oswalt, Jr., CE, and COL Levi A. Brown, CE. Technical Directors were Mr. J. B. Tiffany and Mr. F. R. Brown.

LIST OF PLATES

Plate	Title
Artonish (a)	Distribution of Alluvial Deposits, Artonish, Miss.-La.
Artonish (b)	Sections A-A' and B-B', Artonish, Miss.-La.
Batchelor (a)	Distribution of Alluvial Deposits, Batchelor, La.-Miss.
Batchelor (b)	Sections A-A' and B-B', Batchelor, La.-Miss.
Baton Rouge (a)	Distribution of Alluvial Deposits, Baton Rouge, La.
Baton Rouge (b)	Sections A-A', B-B', and C-C', Baton Rouge, La.
Donaldsonville (a)	Distribution of Alluvial Deposits, Donaldsonville, La.
Donaldsonville (b)	Sections A-A', B-B', and C-C', Donaldsonville, La.
Fordoche (a)	Distribution of Alluvial Deposits, Fordoche, La.
Fordoche (b)	Sections A-A' and B-B', Fordoche, La.
Grosse Tete (a)	Distribution of Alluvial Deposits, Grosse Tete, La.
Grosse Tete (b)	Sections A-A' and B-B', Grosse Tete, La.
New Roads (a)	Distribution of Alluvial Deposits, New Roads, La.
New Roads (b)	Sections A-A' and B-B', New Roads, La.
St. Francisville (a)	Distribution of Alluvial Deposits, St. Francisville, La.-Miss.
St. Francisville (b)	Section A-A', St. Francisville, La.-Miss.
White Castle (a)	Distribution of Alluvial Deposits, White Castle, La.
White Castle (b)	Sections A-A' and B-B', White Castle, La.
Zachary (a)	Distribution of Alluvial Deposits, Zachary, La.
Zachary (b)	Section A-A', Zachary, La.

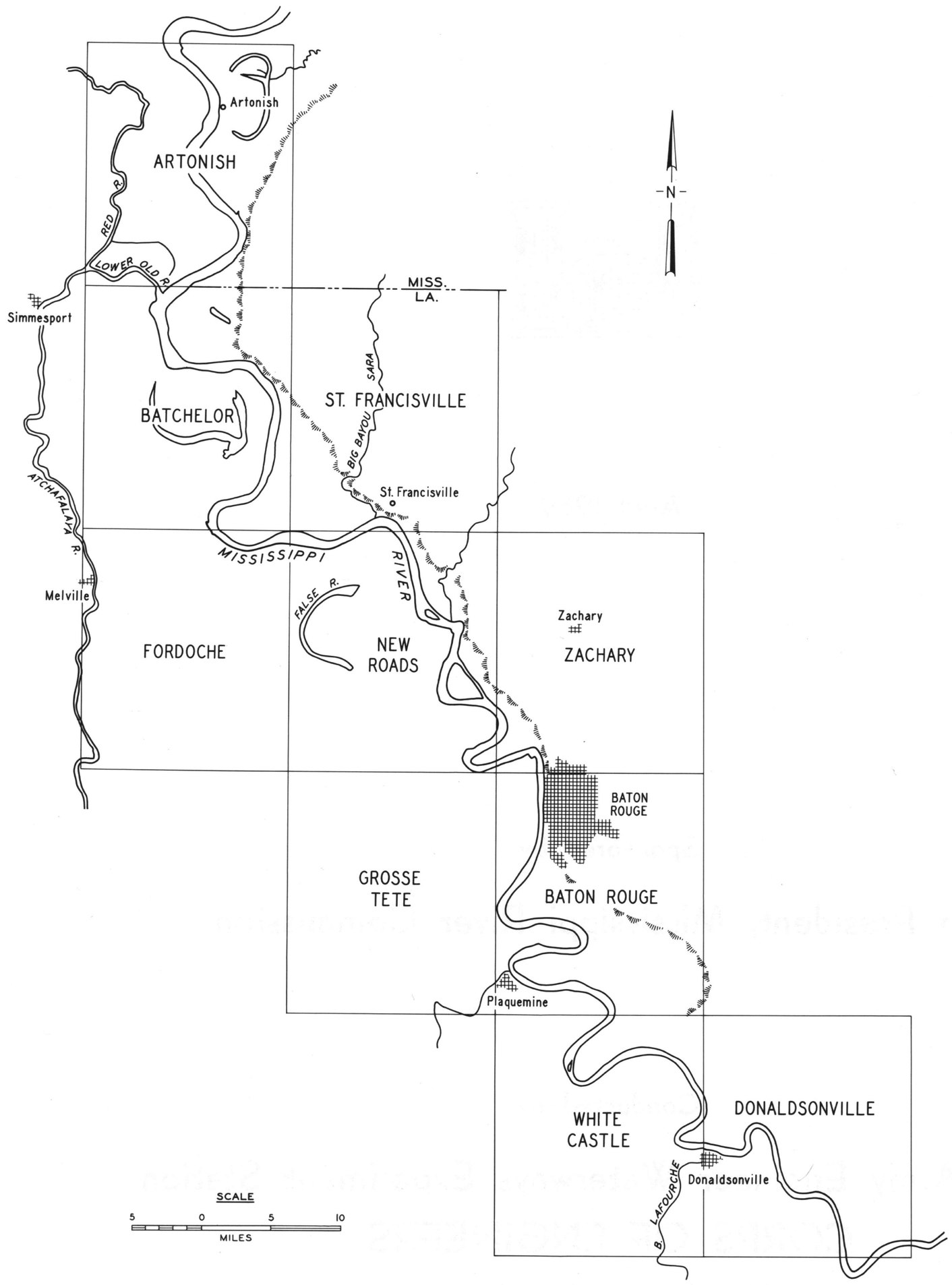


Fig. 1. Quadrangle coverage of the Mississippi River area, Artonish to Donaldsonville, La.